Radiology Case Reports

Volume I, Issue 3, 2006

Wandering Catheter Through Pulmonary Vasculature

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Embolization of central catheter fragments is a rare but well-documented complication of indwelling vascular devices. We describe a unique case of a catheter fragment migrating through the pulmonary vasculature after indwelling reservoir catheter removal in a 42 year-old female with metastatic breast cancer. The catheter fragment was initially visualized in the right upper lobe pulmonary artery (PA) two years after removal. One year later, it was seen in the right middle lobe PA. Two years later, it had migrated to the right lower lobe PA, where it remained for at least three months before the patient was lost to follow-up. The patient remained clinically asymptomatic from the catheter fragment throughout this time. Although there have been numerous case reports published regarding catheter embolization, to our knowledge, migration within the pulmonary vasculature has not been described. This is an interesting illustration of the hemodynamics of pulmonary blood flow and transient retrograde flow in the lungs.

Introduction

Catheter embolization is a well-documented consequence of central venous access devices[1]. Although catheter fragments have been visualized in vascular structures from the cavae to the pulmonary arteries [2,3], to our knowledge, migration of a catheter fragment within the pulmonary vasculature has yet to be described. Because fragments are generally removed once identified, the natural history and course of foreign bodies in the pulmonary vasculature is unknown. This case provides a demonstration of the in vivo hemodynamics of pulmonary blood flow, generally thought to be unidirectional. We present a case illustrating transient reversal of the direction of pulmonary blood flow. A broken indwelling reservoir catheter that was initially lodged in the upper lobe pulmonary artery was later found to be located in the middle lobe PA and finally in the lower lobe PA. The path of travel of the catheter demonstrates that blood in the larger PA's is not completely unidirectional.

Citation: Lee D, Shaffer, K. Wandering catheter through pulmonary vasculature. Radiology Case Reports. [Online] 2006;1:41.

Abbreviations: PA, pulmonary artery, SVC, superior vena cava, CT, computed tomography, IV, intravenous, LA, left atrial, PV, pulmonary vein

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DOI: 10.2484/rcr.v1i3.41

Case Report

A Port-A-Cath® was placed at an outside hospital in a 42 year-old female receiving chemotherapy for Stage II carcinoma of the left breast. She had undergone left modified radical mastectomy and had been diagnosed with poorly differentiated adenocarcinoma. The indwelling reservoir catheter was placed prior to administering four cycles of adjuvant chemotherapy. Its position was confirmed with the catheter entering the right subclavian vein with its tip in the superior vena cava (SVC). Although it was not noted at the time, retrospective review of the films showed the catheter compressed between the first rib and the clavicle at the costoclavicular junction (Figure 1).

The catheter was removed after completing four months of chemotherapy. No films were available immediately following catheter removal. She was in clinical remission for two years, then presented to our institution with progressive fatigue. She was found to have replacement of her bone marrow with metastatic adenocarcinoma. Plain films at that time showed clear lungs with a catheter fragment in the right upper lobe PA (Figure 2).

The patient was followed with expectant management for six months, at which point chest films were repeated. The catheter was now visualized in the right middle lobe PA (Figure 3). Follow-up imaging six months later showed the

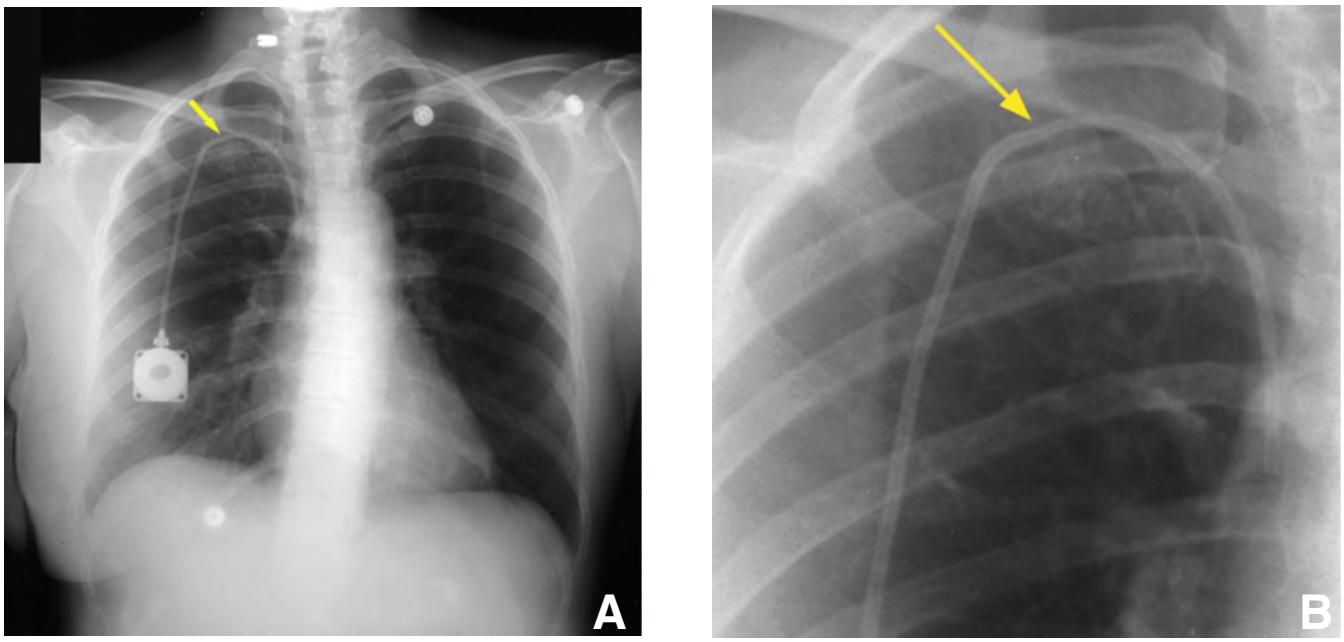

Figure 1. A. Postero-anterior chest radiograph demonstrating original positioning of indwelling reservoir catheter in right subclavian vein with tip in SVC. Catheter was compressed at thoracic inlet between first rib and clavicle (arrow), consistent with "pinch-off sign". Patient is status post left mastectomy. **B.** Close-up view of thoracic inlet area demonstrating compression of catheter at costoclavicular junction (arrow).

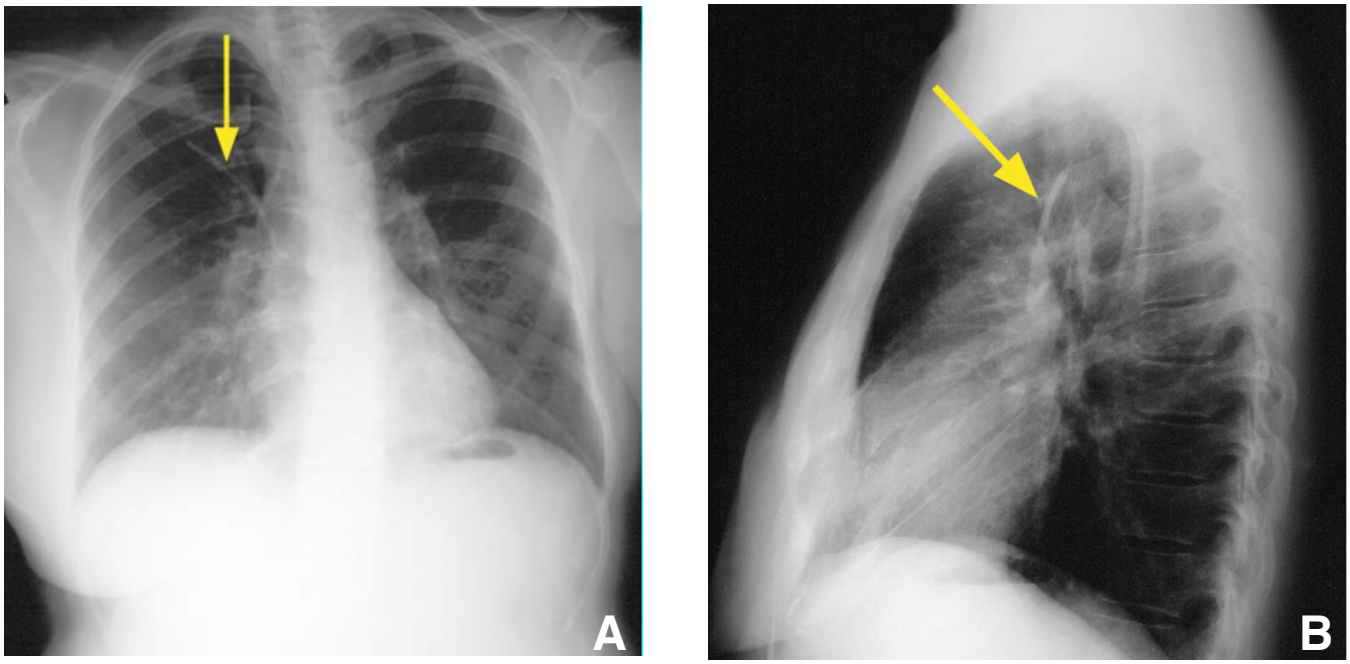

Figure 2. Postero-anterior **A.** and lateral **B.** chest radiographs demonstrating location of catheter fragment in right upper lobe PA two years after removal of indwelling reservoir catheter (arrow). Patient was imaged during evaluation for new onset of fatigue after two-year remission of breast cancer.

catheter fragment in the right lower lobe PA (Figure 4).

The patient's liver function deteriorated over the course of the next year, raising concern for liver metastasis. Baseline computed tomography (CT) was obtained prior to the start of chemotherapy and confirmed the continued presence of the catheter fragment in the right lower lobe PA (5), as well as multiple coalescent liver metastases. The patient was treated with further chemotherapy without notable improvement. Four years after her initial diagnosis and indwelling reservoir catheter placement, she returned to her home in Florida for further care and was lost to follow-up. She remained asymptomatic from the catheter fragment throughout this time period.

Discussion

Central venous catheters, such as Port-A-Caths®, are not without complications and dangers. Perioperative complications include malpositioning, pneumothorax, hemorrhage, and embolization; longer-term postoperative consequences include infection, thrombosis, extravasation, and catheter fracture[1]. Fractured central catheters are a rare occurrence, with an estimated incidence of 0.12%-1.8% among patients with central venous catheters[2,3]. The "pinch-off" sign, first described by Aitken and Minton in 1984[4], has been associated with more than one hundred published cases of catheter fracture secondary to compression between the first rib and the clavicle[5,6]. Case studies of percutaneous removal of intravascular foreign bodies number about 150 in the literature over the past three decades[7].

Migration of portions of central catheters has been described in the past, with retrieval from the cavae[8], right atrium[9], right ventricle[10], and pulmonary arteries[11]. Although many patients, such as this one, have remained asymptomatic[12], migration of catheters has been associated with serious complications such as pulmonary embolism with subsequent pulmonary infarction[13], myocardial or pulmonary parenchymal perforation[14] and palpitations and arrhythmias[15].

Although cases exist of catheter migration to the pulmonary arteries, migration of a catheter from one portion of the pulmonary vasculature to another has yet to be described. Most catheter fragments are removed soon after discovery so as to avoid complications as described above. The natural history of catheter fragments has not been described. Two case reports describe a guide wire and an intravenous (IV) catheter fragment, both of which remained in the pulmonary artery for fourteen and eleven years, respectively, without any clinical sequelae[14,16]. These two case reports do not describe movement of the catheters once they became lodged within the pulmonary arteries. This case further illustrates that removal of a catheter fragment is not absolutely necessary in cases in which the patient is asymptomatic.

The case presented here demonstrates intrapulmonary migration of a catheter over four years. This suggests that pulmonary blood flow is not consistently unidirectional. Pulmonary blood flow is directly proportional to the driving pressure, calculated as the difference between PA pressure and left atrial (LA) pressure (which is taken to be equal to pulmonary capillary wedge pressure). The pulmonary cir-

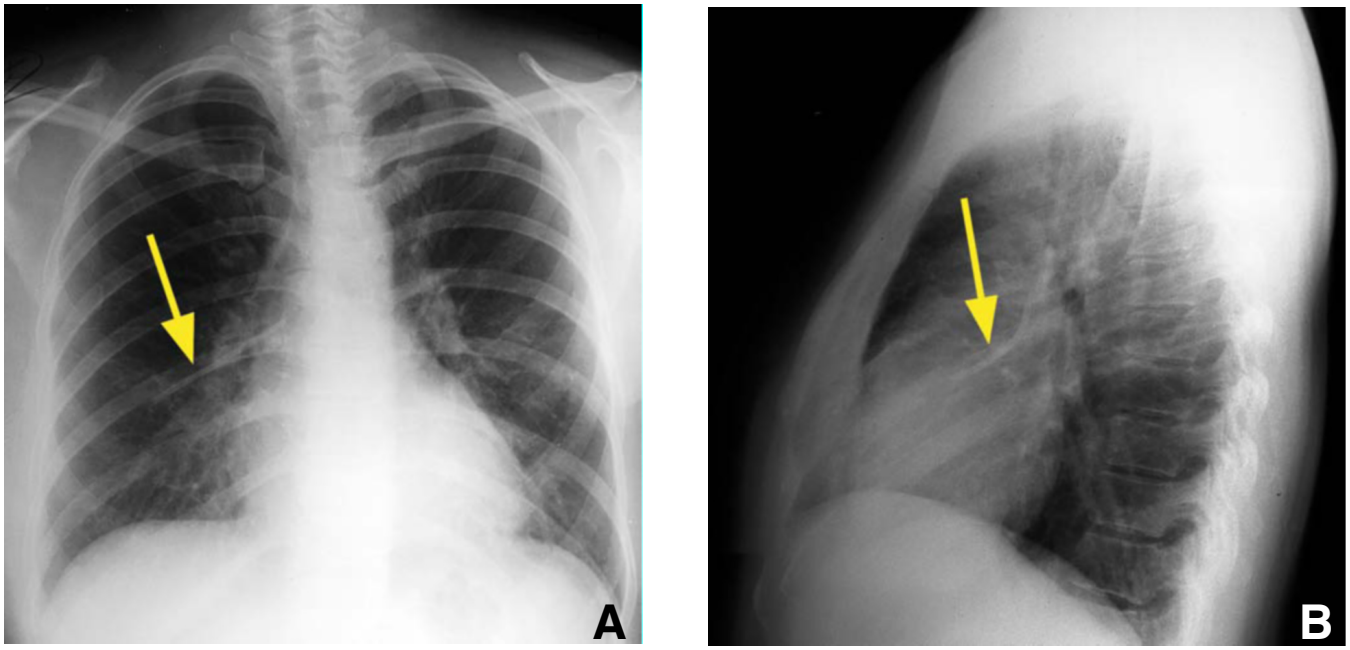

Figure 3. Postero-anterior **A.** and lateral **B.** chest radiographs showing catheter fragment in right middle lobe PA three years after removal of indwelling reservoir catheter (arrow).

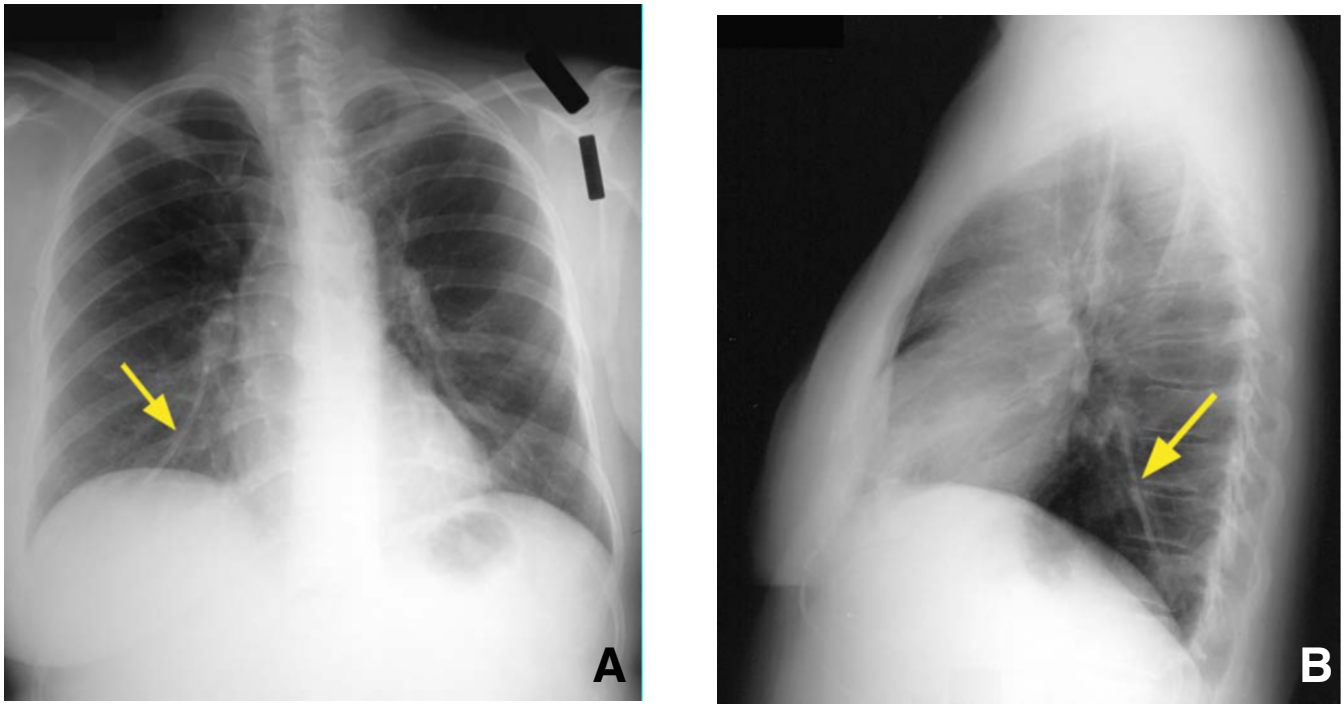

Figure 4. Postero-anterior **A.** and lateral **B.** chest radiographs showing catheter fragment in right lower lobe PA nearly four years after removal of indwelling reservoir catheter (arrow). Resolution of pulmonary abnormality following course of chemotherapy was noted. Patient continued to be asymptomatic from catheter fragment.

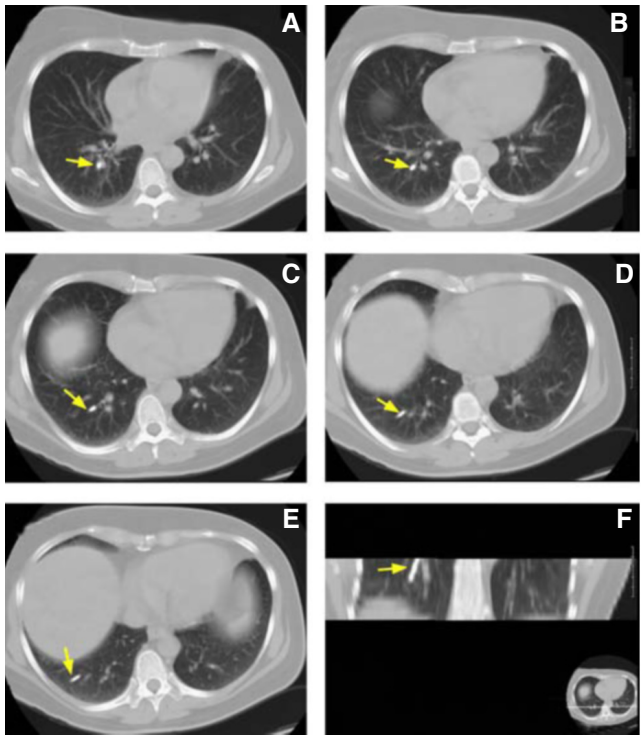

Figure 5. Five axial CT images **A-E.** and one coronal CT image **F.** showing course of catheter fragment in the right lower lobe PA four years after removal of indwelling reservoir catheter. Patient was lost to follow-up after this time, but had remained asymptomatic during course of treatment at our institution.

culation is a low-pressure system, with an average mean main PA pressure of 15 mm Hg and an average LA pressure of 5 mm Hg [17]. The pressure differential impacts not only the amount of blood flow, but the direction of the vector.

Physiologically, the pulmonary pressure increases with gravity. Therefore, at forced residual capacity, the pressure in the lower lobe PA is approximately 18 mmHg greater than the pressure in the upper lobe PA. Since pulmonary vein (PV) pressures vary in a similar manner to PA pressures, the driving pressures are not affected by gravity. Transmural pressure, however, does vary with gravity, thus leading to increased flow to the lower lobes in the upright position [17].

When an individual moves from a supine to a standing position, blood is shifted from the upper to lower regions of the heart, which would explain the eventual migration of the catheter from the upper lobe PA to the lower lobe PA. However, the migration requires that the catheter be displaced from its lodged position within a branch PA and move towards the hilum. This retrograde flow might occur when shifting positions from right lateral decubitus to left lateral decubitus, with a shift in blood flow from the right to left lungs.

Other explanations for retrograde flow would include any mechanism by which alveolar pressure or pulmonary venous pressure exceeded main PA pressure. When intrathoracic pressure is increased and lung volume is decreased with expiration, cough, or Valsalva, the vascular resistance of extra-alveolar vessels increases. At the same time, the

large hilar pulmonary arteries are not subject to caliber changes caused by parenchymal expansion or contraction, and are thus exposed to a relatively constant intrapleural pressure (0 mm Hg with forced expiration with closed glottis). Thus, the peripheral pulmonary vascular pressure could exceed main PA pressure, leading to a reversal in the direction of blood flow. The main PA pressure would be especially vulnerable to such a reversal of direction during diastole, when the PA pressure is approximately 8 mmHg.

The migration of the catheter through the pulmonary vasculature is interesting in its illustration of the dynamic nature of pulmonary blood flow. Whereas we are accustomed to thinking about pulmonary hemodynamics as unidirectional, it is apparent that the low-pressure pulmonary vasculature is subject to many different forces which can transiently change the direction of flow.

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